Reply to "Comment on 'Time-differential perturbed-angular-correlation studies of the amorphous Cu-Hf alloys prepared by mechanical alloying and melt spinning'"

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We present some noteworthy facts for discussion of the short-range order in the amorphous alloys from the time-differential perturbed-angular-correlation (TDPAC) spectra in reply to the comment of Mendoza-Zélis, Damonte, and López García.

Recently Mendoza-Zélis, Damonte, and López García[1] have commented on the experimental results and discussions in our recent paper.[2] They[3,4] observed the time-differential perturbed-angular-correlation (TDPAC) spectra which show a broad distribution of quadrupole frequencies in the amorphous CuHf made by melt spinning. Those spectra are similar to those found by us[2] for the mechanically alloyed amorphous sample. The melt-spun amorphous Cu-Hf alloy prepared by the present authors was confirmed at least from the x-ray-diffraction point of view. Preferably this difference reveals that the TDPAC experiment might be very powerful for confirming the quality of amorphization in comparison with x-ray diffraction. They also concluded that the short-range order of both quenched and milled Cu-Hf amorphous alloys is consistent with a random distribution of atoms. However, we are afraid that their conclusion from TDPAC spectra might be a little bit hasty, as mentioned below.

Figure 1 shows the x-ray-diffraction pattern of the Cu-Hf multilayers ($\lambda \sim 440$ Å). This result reveals certainly that the Hf layers grow along a direction normal to the (002) plane, although the Hf layers are expanded a little. It is thus seen that Hf atoms in the Hf layers are not distributed randomly. Figure 2 shows the asymmetry ratio,

$$R(t)=\frac{3}{2}\left\{\left[\frac{N_{13}(180°,t)N_{24}(180°,t)}{N_{12}(90°,t)N_{23}(90°,t)}\right]^{1/2}-1\right\},$$

from the TDPAC spectra of the Cu-Hf multilayers ($\lambda \sim 440$ Å). The solid line is the fitted one. This asymmetry ratio shows a relatively broad distribution of quadrupole frequencies. In fact the $R(t)$ spectrum is fitted by the frequency $\omega_1 \sim 600$ Mrad/sec with the spread $\delta_1 \sim 200$ Mrad/sec. That is, these results suggest that a broad distribution of quadrupole frequencies does not mean necessarily the random short-range order.

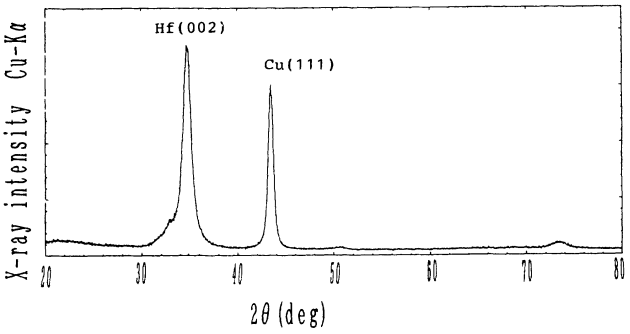

FIG. 1. X-ray-diffraction pattern (arb. units) of Cu-Hf multilayers ($\lambda \sim 440$ Å).

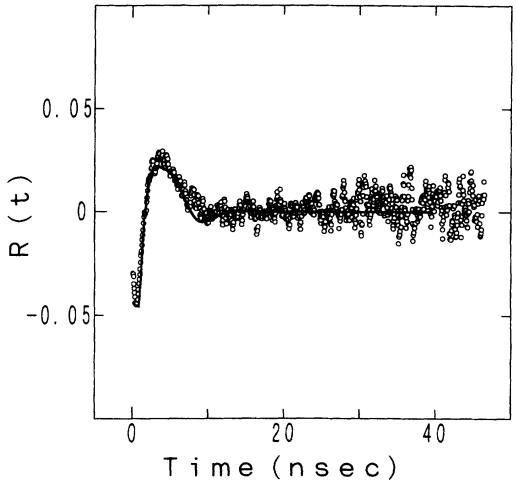

FIG. 2. The asymmetry ratio $R(t)$ of the TDPAC spectra of Cu-Hf multilayers ($\lambda \sim 440$ Å).

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[3] L. C. Damonte, L. Mendoza-Zélis, and A. R. López García, Phys. Rev. B **39**, 12 492 (1989).
[4] L. Mendoza-Zélis, L. C. Damonte, and A. R. López García, Hyperfine Inter. **52**, 161 (1989).